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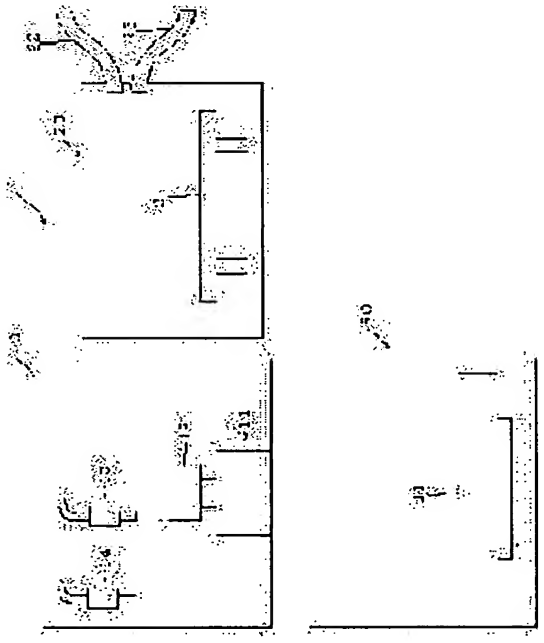
(54) RESIST FILM, ITS FORMATION METHOD AND APPARATUS THEREOF

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a resist film formation method for applying resist with uniform film thickness, a resist film formation apparatus, and a resist film.

SOLUTION: A resist film formation apparatus 1 drops resist onto a still or rotating substrate by a spin coater 10, rotates the substrate for diffusing the resist onto the surface of the substrate by centrifugal force to form a resist layer of nearly uniform film thickness, vertically leaves resist 50 applied onto a substrate 40 as it is in an enclosure 20 for a fixed time, and gradually substitutes gas in the enclosure 20 for outdoor air. Therefore, vapor of a solvent evaporating from the resist is saturated in the enclosure 20, the drying of the resist in the enclosure 20 is suppressed, the resist is fluidized for making the surface flat, and at the same time, the vapor pressure of the solvent in the enclosure 20 is dropped gradually for drying the entire resist film uniformly after the surface becomes flat, thus preventing roughness on the surface of the resist, and hence forming a flat resist film without roughness on the surface.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the resist film formation approach, the resist film formation equipment, and the resist film which apply a resist to a detail by the uniform thickness used for creation of a micro machine and a micro lens etc. about the resist film formation approach, resist film formation equipment, and the resist film.
[0002]
[Description of the Prior Art] What also has various thickness of the resist for which it is recently used also in micro-machining etc., and comes, and a photolithography technique is used although development has mainly been furthered in the semi-conductor field, construction material of a substrate substrate, and configurations is used increasingly.
[0003] In a photolithography, in order to imprint a pattern to accuracy, it is required to apply the resist film evenly without nonuniformity, but when a big level difference is in a case so that the thickness of the resist film may be set to several 10 um(s), or a substrate, it is difficult to apply the resist film to homogeneity.
[0004] Since desiccation takes time amount immediately after specifically carrying out a spin coat when applying the resist film thickly even when thickness is uniform, thickness may be sharply changed by the drying mark, or a tortoise shell-like pattern may occur on a front face in contraction by the resist front face, the difference of an internal rate of drying, and desiccation. Moreover, in performing a spin coat to a substrate with a high level difference, it becomes unsymmetrical thickness by the core [of the level difference section], and circumference side, or nonuniformity occurs in a radial from the break of a pattern.
[0005] Then, the process which applies the solvent of coating liquid on the whole surface of the substrate rotated or suspended conventionally, The process which rotates the substrate with which the above-mentioned solvent was applied at the 1st rotational frequency, and diffuses a solvent over the whole whole surface of a substrate, The spreading film formation approach of having the process of the above-mentioned substrate which is made rotating a substrate at the 2nd rotational frequency, is made diffusing the coating liquid of the specified quantity over the whole whole surface of a substrate, and forms the spreading film on a core mostly is proposed. Moreover, in this proposal In case a resist is extended on a substrate front face, rotating a substrate, the substrate circumference is made into the saturation ambient atmosphere of a solvent, desiccation of a resist is prevented, and the method of avoiding spreading nonuniformity is also proposed (refer to JP,7-320999,A).
[0006] Moreover, the resist coater which rotates the means which is conventionally equipped with a means to hold a semi-conductor wafer horizontally, a means by which a resist is dropped at the core of the front face of said semi-conductor wafer, a means to rotate a means to hold said semi-conductor wafer, with said semi-conductor wafer, and the means that encloses said semi-conductor wafer, and encloses said semi-conductor wafer with said semi-conductor wafer is proposed (refer to JP,6-260404,A).

[0007] That is, this conventional resist coater seals a substrate using the cup and lid surrounding the wafer circumference, in order to press down scattering of a resist, control of the air current of the wafer circumference and desiccation on the front face of a resist are prevented by rotating them together with a substrate, and the even front face is made to be obtained.
[0008] Furthermore, the method of application of the photoresist which has the process which applies a liquefied photoresist to a substrate conventionally and obtains the photoresist film, and the process which makes the basis of a reduced pressure ambient atmosphere carry out predetermined time desiccation of the obtained photoresist film is proposed (refer to JP,8-194316,A).
[0009] That is, after the method of application of this conventional photoresist applies and extends a resist to a substrate by the spin coater, it is drying in the condition of having put the substrate into the vacuum chamber and having decompressed to it, and has prevented the desiccation nonuniformity generated after spreading before drying.
[0010]
[Problem(s) to be Solved by the Invention] If it is in a technique given [above-mentioned] in an official report, a spin coat is performed in the solvent ambient atmosphere of a resist, the unevenness by surface desiccation is prevented, or a substrate is put in behind a spin coat at a reduced pressure chamber, and reduced pressure drying of the resist is carried out.
[0011] However, by the approach of rotating in a solvent ambient atmosphere, although the thickness fluctuation at the time of carrying out elevated-temperature desiccation of the resist although the surface desiccation under revolution is avoided cannot be avoided and a resist can prevent from flowing before elevated-temperature desiccation by the desiccation approach by the reduced pressure chamber, deterioration of a surface dry area or a resist may take place. Furthermore, by the approach of performing revolution spreading, there is a problem that resist thickness will become unsymmetrical with a level difference.
[0012] Then, even if this invention is the case where a big level difference is in the case where resist thickness is very thick, or a substrate, it aims at offering the resist film formation approach, the resist film formation equipment, and the resist film which there is no surface dry area and can form the flat resist film.
[0013] Invention according to claim 1 specifically trickles a resist on the substrate which is stopping or rotating. It faces forming the resist layer of uniform thickness and forming the resist film which is made to carry out stoving of the resist layer on a substrate, and performs it. a substrate is rotated and a resist is diffused on a substrate front face with a centrifugal force -- making -- a substrate top -- abbreviation -- By carrying out fixed time amount neglect and permuting the gas and the open air in the container concerned gradually in the container which had the substrate with which the resist was applied sealed In putting a substrate into a well-closed container immediately after applying a resist, and the steam of the solvent which evaporates from a resist being saturated within a well-closed container While controlling desiccation of the resist within a container, and a resist's flowing and making a front face flat Also as opposed to the substrate which homogeneity is made to dry the whole resist film, prevents the surface dry area of a resist, and has the thick resist of thickness, and a level difference by lowering the vapor pressure of the solvent in a container gradually after becoming flat It aims at offering the resist film formation approach which there is no surface dry area and can form the flat resist film with a sufficient precision.
[0014] After invention according to claim 2 picks out a substrate from a container, by removing the resist of the periphery section of the substrate concerned, even when a thick-film resist is used, it removes the resist of the periphery section, and aims at offering the resist film formation approach which there is no surface dry area and can form the flat resist film with a sufficient precision.
[0015] Invention according to claim 3 trickles a resist on the substrate which is stopping or rotating. It faces forming the resist layer of uniform thickness and forming the resist film which is made to carry out stoving of the resist layer on a substrate, and performs it. a substrate is rotated and a resist is diffused on a substrate front face with a centrifugal force -- making -- a substrate top -- abbreviation -- By carrying out fixed time amount neglect of the substrate with which the resist was applied into a well-closed

container means, and permuting gradually the gas and the open air within the well-closed container means concerned In putting a substrate into a well-closed container means immediately after applying a resist, and the steam of the solvent which evaporates from a resist being saturated within a well-closed container means While controlling desiccation of the resist within a well-closed container means, and a resist's flowing and making a front face flat After becoming flat, the vapor pressure of the solvent within a well-closed container means by lowering gradually Homogeneity is made to dry the whole resist film, the surface dry area of a resist is prevented, and it aims at offering the resist film formation equipment which there is no surface dry area and can form the flat resist film with a sufficient precision also to a substrate with the thick resist of thickness, or a level difference.

[0016] Invention according to claim 4 by preparing opening which permutes an internal gas and the internal open air by the well-closed container means Control the ambient atmosphere inside a substrate sealing means easily, and make homogeneity dry the whole resist film more, and easy and a substrate with the thick resist of thickness or a level difference are also received. It aims at offering the resist film formation equipment which there is no surface dry area further and can form the flat resist film with a much more sufficient precision.

[0017] Invention according to claim 5 aims at offering the resist film formation equipment which it prevents that resist thickness inclines toward a well-closed container means on the dip of a substrate by preparing the substrate attaching part which holds the substrate concerned in the condition that the front face of a substrate becomes level, and there is no surface dry area further also to a substrate with the thick resist of thickness, or a level difference, and can form the flat resist film with a much more sufficient precision.

[0018] Invention according to claim 6 aims at offering the resist film formation equipment which forms the flat resist film also to a substrate which has curvature by giving the curvature amendment function which amends the curvature of a substrate, and there is no surface dry area in a substrate attaching part further, and can form the flat resist film in it with a much more sufficient precision.

[0019] The vacuum adsorption device in which invention according to claim 7 carries out vacuum adsorption of the substrate attaching part on a flat holder and the holder concerned, and said substrate is stuck, By sticking said substrate to a preparation and the flat holder concerned, and amending the curvature of the substrate concerned It aims at offering the resist film formation equipment which forms the flat resist film appropriately and easily also to a substrate which has curvature, and there is no surface dry area further and can form the flat resist film with a much more sufficient precision.

[0020] The electrostatic adsorption device in which invention according to claim 8 carries out electrostatic adsorption of the substrate attaching part on a flat holder and the holder concerned, and said substrate is stuck, By sticking said substrate to a preparation and the flat holder concerned, and amending the curvature of the substrate concerned It aims at offering the resist film formation equipment which forms the flat resist film appropriately and easily also to a substrate which has curvature, and there is no surface dry area further and can form the flat resist film with a much more sufficient precision.

[0021] Invention according to claim 9 the resist film with which a resist is dropped and formed on a substrate By forming in either of the resist film formation approach according to claim 1 or 2 or claim 3 to claims 8 with the resist film formation equipment of a publication Form the flat resist film appropriately and easily also to a substrate which has curvature, and there is no surface dry area and the flat resist film is formed with a sufficient precision. A three-dimension-resist pattern is created or it aims at offering the resist film which the yield in the case of performing patterning on a substrate with a level difference can raise.

[0022]

[Means for Solving the Problem] The resist film formation approach of invention according to claim 1 a resist is dropped on the substrate which is stopping or rotating, a substrate is rotated, and a resist is diffused on a substrate front face with a centrifugal force -- making -- a substrate top -- abbreviation -- with the resist spreading process which forms the resist layer of uniform thickness In the resist film formation approach of performing the desiccation process to which stoving of the resist layer on a

substrate is carried out The above-mentioned object is attained by including the neglect process which carries out fixed time amount neglect into the container which had the substrate with which the resist was applied at said resist spreading process sealed, and the gas in the container concerned and the gas permutation process of permuting the open air gradually.
[0023] According to the above-mentioned configuration, a resist is dropped on the substrate which is stopping or rotating. It faces forming the resist layer of uniform thickness and forming the resist film which is made to carry out stoving of the resist layer on a substrate, and performs it. a substrate is rotated and a resist is diffused on a substrate front face with a centrifugal force -- making -- a substrate top -- abbreviation -- Since fixed time amount neglect is carried out and the gas and the open air in the container concerned are gradually permuted in the container which had the substrate with which the resist was applied sealed In putting a substrate into a well-closed container immediately after applying a resist, and the steam of the solvent which evaporates from a resist being saturated within a well-closed container While being able to control desiccation of the resist within a container, and a resist's being able to flow and being able to make a front face flat After becoming flat, by lowering the vapor pressure of the solvent in a container gradually, homogeneity can be made to be able to dry the whole resist film, the surface dry area of a resist can be prevented, there is no surface dry area also to a substrate with the thick resist of thickness, or a level difference, and the flat resist film can be formed with a sufficient precision.
[0024] After picking out said substrate from said container, said resist film formation approach may include the clearance process which removes the resist of the periphery section of the substrate concerned, so that it may indicate to claim 2 in this case.
[0025] Since according to the above-mentioned configuration the resist of the periphery section of the substrate concerned is removed after picking out a substrate from a container, even when a thick-film resist is used, the resist of the periphery section can be removed, there is no surface dry area, and the flat resist film can be formed with a sufficient precision.
[0026] The resist film formation equipment of invention according to claim 3 A resist dropping means by which a resist is dropped on the substrate which is stopping or rotating, said substrate is rotated and said dropped resist is diffused on a substrate front face with a centrifugal force -- making -- the substrate top concerned -- abbreviation -- with a substrate revolution means to make the resist layer of uniform thickness form A well-closed container means to leave the substrate with which said resist layer was formed in the state of sealing, The above-mentioned object is attained by having the gas within said well-closed container means, a gas permutation means to permute the open air gradually, and the desiccation means that carries out stoving of the resist layer on said substrate after the gas was permuted by said gas permutation means.
[0027] According to the above-mentioned configuration, a resist is dropped on the substrate which is stopping or rotating. It faces forming the resist layer of uniform thickness and forming the resist film which is made to carry out stoving of the resist layer on a substrate, and performs it. a substrate is rotated and a resist is diffused on a substrate front face with a centrifugal force -- making -- a substrate top -- abbreviation -- Since fixed time amount neglect of the substrate with which the resist was applied is carried out into a well-closed container means and the gas and the open air within the well-closed container means concerned are permuted gradually In putting a substrate into a well-closed container means immediately after applying a resist, and the steam of the solvent which evaporates from a resist being saturated within a well-closed container means While being able to control desiccation of the resist within a well-closed container means, and a resist's being able to flow and being able to make a front face flat After becoming flat, the vapor pressure of the solvent within a well-closed container means by lowering gradually Homogeneity can be made to be able to dry the whole resist film, the surface dry area of a resist can be prevented, there is no surface dry area also to a substrate with the thick resist of thickness, or a level difference, and the flat resist film can be formed with a sufficient precision.

[0028] Said well-closed container means may be equipped with opening which permutes an internal gas and the internal open air so that it may indicate to claim 4 in this case.

[0029] Since opening which permutes an internal gas and the internal open air by the well-closed container means is prepared according to the above-mentioned configuration, the ambient atmosphere inside a substrate sealing means is easily controllable, homogeneity is made to dry the whole resist film more, there is no surface dry area further also to easy and a substrate with the thick resist of thickness, or a level difference, and the flat resist film can be formed with a much more sufficient precision.
[0030] Moreover, for example, said well-closed container means may be equipped with the substrate attaching part which holds the substrate concerned in the condition that the front face of said substrate becomes level so that it may indicate to claim 5.
[0031] According to the above-mentioned configuration, it can prevent that resist thickness inclines toward it on the dip of a substrate since the substrate attaching part which holds the substrate concerned in the condition that the front face of a substrate becomes level is prepared in the well-closed container means, there is no surface dry area further also to a substrate with the thick resist of thickness, or a level difference, and the flat resist film can be formed with a much more sufficient precision.
[0032] Furthermore, for example, said substrate attaching part may be equipped with the curvature amendment function which amends the curvature of said substrate so that it may indicate to claim 6.
[0033] According to the above-mentioned configuration, since the curvature amendment function which amends the curvature of a substrate is given to the substrate attaching part, the flat resist film can be formed also to a substrate which has curvature, there is no surface dry area in it further, and the flat resist film can be formed in it with a much more sufficient precision.
[0034] Moreover, for example, said substrate attaching part may be equipped with a flat holder and the vacuum adsorption device in which carry out vacuum adsorption and said substrate is stuck on the holder concerned, may stick said substrate to the flat holder concerned, and may amend the curvature of the substrate concerned so that it may indicate to claim 7.
[0035] Since according to the above-mentioned configuration it should have the vacuum adsorption device in which carried out vacuum adsorption of said substrate, and a substrate attaching part was stuck on a flat holder and the holder concerned, said substrate should be stuck to the flat holder concerned and the curvature of the substrate concerned shall be amended The flat resist film can be formed appropriately and easily also to a substrate which has curvature, there is no surface dry area further and the flat resist film can be formed with a much more sufficient precision.
[0036] Furthermore, for example, said substrate attaching part may be equipped with a flat holder and the electrostatic adsorption device in which carry out electrostatic adsorption and said substrate is stuck on the holder concerned, may stick said substrate to the flat holder concerned, and may amend the curvature of the substrate concerned so that it may indicate to claim 8.
[0037] Since according to the above-mentioned configuration it should have the electrostatic adsorption device in which carried out electrostatic adsorption of said substrate, and a substrate attaching part was stuck on a flat holder and the holder concerned, said substrate should be stuck to the flat holder concerned and the curvature of the substrate concerned shall be amended The flat resist film can be formed appropriately and easily also to a substrate which has curvature, there is no surface dry area further and the flat resist film can be formed with a much more sufficient precision.
[0038] The resist film of invention according to claim 9 is resist film with which a resist is dropped and formed on a substrate, and has attained the above-mentioned object by being formed in either of the resist film formation approach according to claim 1 or 2 or claim 3 to claims 8 with the resist film formation equipment of a publication.
[0039] Since the resist film with which a resist is dropped and formed on a substrate is formed in either of the resist film formation approach according to claim 1 or 2 or claim 3 to claims 8 with the resist film formation equipment of a publication according to the above-mentioned configuration Can form the flat resist film appropriately and easily also to a substrate which has curvature, there is no surface dry area, and the flat resist film is formed with a sufficient precision. A three-dimension-resist pattern can be created or the yield in the case of performing patterning on a substrate with a level difference can be raised.
[0040]

[Embodiment of the Invention] Hereafter, the gestalt of suitable operation of this invention is explained to a detail based on an accompanying drawing. In addition, since the gestalt of the operation described below is a gestalt of suitable operation of this invention, desirable various definition is attached technically, but especially the range of this invention is not restricted to these modes, as long as there is no publication of the purport which limits this invention in the following explanation.
[0041] Drawing 1 - drawing 8 are drawings showing the gestalt of 1 operation of the resist film formation approach of this invention, resist film formation equipment, and the resist film, and drawing 1 is the outline block diagram of the resist film formation equipment which applied the gestalt of 1 operation of the resist film formation approach of this invention, resist film formation equipment, and the resist film.
[0042] Resist film formation equipment 1 is equipped with the spin coater 10, the well-closed container 20, and the hot plate container 30 grade in drawing 1 .
[0043] Although the spin coater (a resist dropping means, substrate revolution means) 10 is not illustrated while it is equipped with the substrate holder 12 and two dispensers 13 which were connected with the shaft of a motor 11 and a motor 11, and 14 grades, it is equipped with the air-conditioner troller which controls the ambient atmosphere in a spin coater 10, and applies a resist to the substrate 40 (refer to drawing 2) laid on a motor 11.
[0044] A well-closed container (well-closed container means) 20 is a container for sealing the substrate 40 with which the resist was applied, and is equipped with the exhaust-port (gas permutation means, opening) 23 grade for discharging the gas in the open air incorporation opening (a gas permutation means, opening) 22 for introducing the open air into the stage 21 for substrate maintenance, and a well-closed container 20, and a well-closed container 20. In addition, the well-closed container 20 may equip the transport device for conveying a substrate 40, and the substrate 40 before resist spreading with the equipment for forming a resist adhesion layer etc.
[0045] The hot plate container (desiccation means) 30 has held the hot plate 31, the substrate 40 with which the resist film was formed, and dries the resist film in the condition of having been suitable for exposure.
[0046] Next, the resist film formation process using resist film formation equipment 1 is explained based on drawing 7 from drawing 2 .
[0047] First, a resist 50 is dropped on a substrate 40, making the substrate 40 which performed surface treatment for raising the adhesion of a resist with HMDS (hexamethyldisilazane) processing etc. hold to the substrate holder 12 of a spin coater 10, and rotating a motor 11 at quiescence or a low speed (1000 or less rpm extent), as shown in drawing 2 . And after the resist 50 of extent which spreads enough all over a substrate 40 is dropped, as shown in drawing 3 , a resist 50 spreads round the whole front face of a substrate 40 with the centrifugal force of a revolution of a substrate 40, and the resist spreading process of rotating a motor 11 so that it may become required thickness is performed.
[0048] Although the unnecessary resist 50 is shaken off besides a substrate 40 with the centrifugal force of a revolution of a substrate 40 at this time, in order that a resist 50 may still remain in the periphery section of a substrate 40 thickly, the last may be made to carry out a high-speed revolution several seconds, and the surrounding resist 50 may be removed at it. In this phase, the front face of a substrate 40 does not have the completely flat need, and the resist 50 of a complement should just remain in forming target thickness on the substrate 40. Moreover, since it is necessary to make it the front face of a resist 50 not dry, when it carries out by removing the unnecessary resist 50 at this event, it is desirable to suspend a revolution of a motor 11, to shorten the processing time or to make the surrounding ambient atmosphere of a substrate 40 into the saturation ambient atmosphere of a resist solvent promptly.
[0049] If a resist 50 is applied to a substrate 40 as mentioned above, as shown in drawing 4 , a substrate 40 will be promptly moved into a well-closed container 20, and the neglect process which carries out fixed time amount neglect will be performed. With the solvent of a resist 50 with which the inside of a well-closed container 20 evaporates from the front face of a substrate 40 at this time, since it becomes the saturation ambient atmosphere of a solvent, a resist 50 flows on a substrate 40, without drying. Moreover, a substrate 40 is held at a level with the stage 21 for substrate maintenance within a well-

closed container 20, and is in the condition that there are no big curvature and big wave in the front face of a substrate 40. In addition, when a wave and camber are in a substrate 40, as a stage 21 for substrate maintenance in a well-closed container 20 (holder), vacuum adsorption and the thing which carries out electrostatic adsorption and which is compulsorily made flat are used for a substrate 4, and a curvature amendment function is given. Although it is dependent also on the viscosity of a resist 50, or thickness by changing into such a condition, the front face of a substrate 40 becomes flat in about several minutes.

[0050] Next, as shown in drawing 5 , the open air incorporation opening 22 of a well-closed container 20 is opened, and the gas permutation process of drying lowering and a resist 50 and making the concentration of an internal resist solvent ambient atmosphere a resist 50 not flow is performed. In this case, by diffusing automatically the resist solvent steam in a well-closed container 20 from the open air incorporation opening 22, the concentration of the resist solvent steam in a well-closed container 20 is lowered gradually, and a resist 50 is dried slowly. Under the present circumstances, although the open air is adopted compulsorily and you may make it exhaust the ambient atmosphere of the well-closed container 20 interior in a well-closed container 20, if the open air is adopted too much rapidly, since the desiccation nonuniformity of a resist 50 may occur and irregularity may arise on the front face of a resist 50, a surface dry area sets and performs compulsory introduction of the open air to extent which is not.
[0051] Since the air current generated in the well-closed container 20 interior also causes [of a surface dry area] generating when adopting the open air in a well-closed container 20, open air incorporation opening 22 is made into the configuration which an air current cannot generate easily in the well-closed container 20 interior.
[0052] In addition, although the gestalt of the above-mentioned implementation explained the case where a fresh air intake 22 was attached in a well-closed container 20, the lid of a well-closed container 20 opens and you may make it adjust in condition.
[0053] Next, from a well-closed container 20, a substrate 40 is returned to a spin coater 10, as shown in drawing and drawing 6 , and the clearance process which removes the resist 50 of the periphery of a substrate 40 from a dispenser 14 using a resist solvent or the solvent 15 only for periphery washing is performed. That is, since a resist 50 presses down this edge part by the clamp and fixes a substrate 40 when it is the edge neighborhood, and there are a periphery of a substrate 40 and a case where the edge of a resist 50 rises and it processes etching etc. after lithography especially as shown in drawing 5 , it is desirable to remove a resist 50. In addition, the periphery of a resist 50 is not removed for a resist 50 flowing and flowing to an edge in this phase in the phase which is made to rotate the motor 11 of drawing 3 and makes a resist 50 homogeneity, even if it removes the resist 50 of a periphery. Moreover, although it is the phase of drawing 3 and clearance of the periphery of a resist 50 is also simultaneously performed when applying the resist 50 of 1um extent to the flat substrate 40 In this case, it is because desiccation of a resist 50 is also performed simultaneously, rotating a motor 11, and since it is difficult to make it dry, making it rotate when forming the thick resist 50, it is the phase of drawing 6 and the periphery of a resist 50 is removed.
[0054] And finally, as shown in drawing 7 , the substrate 40 from which the resist 50 of a periphery was removed is installed on the hot plate 31 in the hot plate container 30, a hot plate 31 performs BEKU, and the desiccation process which dries a resist 50 to the condition suitable for exposure is performed.
[0055] Thus, even if the formed resist film 50 is the thick-film resist 50, it can make a front face flat, and it can raise the yield of a manufacture process also in a manufacture process sensitive to fluctuation of the resist thickness within a wafer, for example, the process which creates a three-dimension-resist pattern. Moreover, when the irregularity of a substrate is exposed to the intense substrate 40 using a stepper, the thickness fluctuation by the side of the core of the substrate 40 of the substrate level difference section and a periphery can be reduced, and the dimension variation between exposure shots can be reduced.
[0056] Thus, the resist film formation approach of the gestalt this operation and resist film formation equipment 1 are changing into the level condition the resist 50 applied on the substrate 40 by the spin coater 10 during 1 scheduled time within the well-closed container 20.

[0057] Therefore, the flat resist film 50 can be formed also to the substrate 40 which has a level difference in the thick resist 50 which unevenness tends to generate with the fluidity of a resist 50, or a substrate.
[0058] Moreover, the solvent which evaporates from the resist 50 applied to the substrate 40 is used for the resist film formation approach of the gestalt this operation, and resist film formation equipment 1 in order to make the inside of a well-closed container 20 a resist solvent ambient atmosphere.
[0059] Therefore, a resist surface dry area can be prevented by drying the resist film 50 which did not need to add the equipment for making it a solvent ambient atmosphere, and became flat in a resist solvent ambient atmosphere [a little] thinner than a saturation state, standing it still.
[0060] In addition, as a well-closed container 20 which an air current cannot generate easily inside the above, the well-closed container (well-closed container means) 60 as shown in drawing 8 can be used, for example. This well-closed container 60 is classified into the plenum chamber 61 by which the interior was formed in the upside, and this room 62 formed in the bottom by the septum 63, and the opening 64 which opens a plenum chamber 61 and this room 62 for free passage is formed in the septum 63. The stage 21 for substrate maintenance is arranged in this room 62, and the substrate 40 with which the resist 50 was applied is introduced and laid from the wafer inlet formed in the side face of this room 62 on this stage 21 for substrate maintenance. This wafer inlet is closed by the lid 65 and a lid 65 is opened at the time of insertion of a substrate 40 and fetch. In the well-closed container 60, opening of the inlet port (a gas permutation means, opening) 66 is carried out to the up center section of the plenum chamber 61, and the exhaust port (a gas permutation means, opening) 67 which discharges the gas in this room 62 outside is formed in the lower part of this room 62.
[0061] In this well-closed container 60, the air with which the air which entered from the inlet port 66 was introduced into the plenum chamber 61, and was first introduced into the plenum chamber 61 is supplied to up to the substrate 40 in this room 62 on which the substrate 40 is uniformly put from the opening 64 prepared in the septum 63, and the gas containing the steam of a resist solvent is discharged from an exhaust port 67. [much] Exhaust air of the direction which exhausted by making it the configuration of such a well-closed container 60 can be managed easily to issue exhaust air containing the steam of a resist solvent outside.
[0062] As mentioned above, although invention made by this invention person was concretely explained based on the gestalt of suitable operation, it cannot be overemphasized that it can change variously in the range which this invention is not limited to the above-mentioned thing, and does not deviate from the summary.
[0063]
[Effect of the Invention] According to the resist film formation approach of invention according to claim 1, a resist is dropped on the substrate which is stopping or rotating. It faces forming the resist layer of uniform thickness and forming the resist film which is made to carry out stoving of the resist layer on a substrate, and performs it. a substrate is rotated and a resist is diffused on a substrate front face with a centrifugal force -- making -- a substrate top -- abbreviation -- Since fixed time amount neglect is carried out and the gas and the open air in the container concerned are gradually permuted in the container which had the substrate with which the resist was applied sealed In putting a substrate into a well-closed container immediately after applying a resist, and the steam of the solvent which evaporates from a resist being saturated within a well-closed container While being able to control desiccation of the resist within a container, and a resist's being able to flow and being able to make a front face flat After becoming flat, by lowering the vapor pressure of the solvent in a container gradually, homogeneity can be made to be able to dry the whole resist film, the surface dry area of a resist can be prevented, there is no surface dry area also to a substrate with the thick resist of thickness, or a level difference, and the flat resist film can be formed with a sufficient precision.
[0064] Since according to the resist film formation approach of invention according to claim 2 the resist of the periphery section of the substrate concerned is removed after picking out a substrate from a container, even when a thick-film resist is used, the resist of the periphery section can be removed, there is no surface dry area, and the flat resist film can be formed with a sufficient precision.

[0065] According to the resist film formation equipment of invention according to claim 3, a resist is dropped on the substrate which is stopping or rotating. It faces forming the resist layer of uniform thickness and forming the resist film which is made to carry out stoving of the resist layer on a substrate, and performs it. a substrate is rotated and a resist is diffused on a substrate front face with a centrifugal force -- making -- a substrate top -- abbreviation -- Since fixed time amount neglect of the substrate with which the resist was applied is carried out into a well-closed container means and the gas and the open air within the well-closed container means concerned are permuted gradually In putting a substrate into a well-closed container means immediately after applying a resist, and the steam of the solvent which evaporates from a resist being saturated within a well-closed container means While being able to control desiccation of the resist within a well-closed container means, and a resist's being able to flow and being able to make a front face flat After becoming flat, the vapor pressure of the solvent within a well-closed container means by lowering gradually Homogeneity can be made to be able to dry the whole resist film, the surface dry area of a resist can be prevented, there is no surface dry area also to a substrate with the thick resist of thickness, or a level difference, and the flat resist film can be formed with a sufficient precision.
[0066] Since opening which permutes an internal gas and the internal open air by the well-closed container means is prepared according to the resist film formation equipment of invention according to claim 4, the ambient atmosphere inside a substrate sealing means is easily controllable, homogeneity is made to dry the whole resist film more, there is no surface dry area further also to easy and a substrate with the thick resist of thickness, or a level difference, and the flat resist film can be formed with a much more sufficient precision.
[0067] According to the resist film formation equipment of invention according to claim 5, it can prevent that resist thickness inclines toward it on the dip of a substrate since the substrate attaching part which holds the substrate concerned in the condition that the front face of a substrate becomes level is prepared in the well-closed container means, there is no surface dry area further also to a substrate with the thick resist of thickness, or a level difference, and the flat resist film can be formed with a much more sufficient precision.
[0068] According to the resist film formation equipment of invention according to claim 6, since the curvature amendment function which amends the curvature of a substrate is given to the substrate attaching part, the flat resist film can be formed also to a substrate which has curvature, there is no surface dry area in it further, and the flat resist film can be formed in it with a much more sufficient precision.
[0069] According to the resist film formation equipment of invention according to claim 7, a substrate attaching part A flat holder, Since it should have the vacuum adsorption device in which carried out vacuum adsorption and said substrate was stuck on the holder concerned, said substrate should be stuck to the flat holder concerned and the curvature of the substrate concerned shall be amended The flat resist film can be formed appropriately and easily also to a substrate which has curvature, there is no surface dry area further and the flat resist film can be formed with a much more sufficient precision.
[0070] According to the resist film formation equipment of invention according to claim 8, a substrate attaching part A flat holder, Since it should have the electrostatic adsorption device in which carried out electrostatic adsorption and said substrate was stuck on the holder concerned, said substrate should be stuck to the flat holder concerned and the curvature of the substrate concerned shall be amended The flat resist film can be formed appropriately and easily also to a substrate which has curvature, there is no surface dry area further and the flat resist film can be formed with a much more sufficient precision.
[0071] According to the resist film of invention according to claim 9, the resist film with which a resist is dropped and formed on a substrate Since it forms in either of the resist film formation approach according to claim 1 or 2 or claim 3 to claims 8 with the resist film formation equipment of a publication Can form the flat resist film appropriately and easily also to a substrate which has curvature, there is no surface dry area, and the flat resist film is formed with a sufficient precision. A three-dimension-resist pattern can be created or the yield in the case of performing patterning on a substrate with a level difference can be raised.

[Translation done.]

* NOTICES *

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the resist film formation approach, the resist film formation equipment, and the resist film which apply a resist to a detail by the uniform thickness used for creation of a micro machine and a micro lens etc. about the resist film formation approach, resist film formation equipment, and the resist film.

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] a resist is dropped on the substrate which is stopping or rotating, a substrate is rotated, and a resist is diffused on a substrate front face with a centrifugal force -- making -- a substrate top -- abbreviation -- with the resist spreading process which forms the resist layer of uniform thickness In the resist film formation approach of performing the desiccation process to which stoving of the resist layer on a substrate is carried out The resist film formation approach characterized by including the neglect process which carries out fixed time amount neglect into the container which had the substrate with which the resist was applied at said resist spreading process sealed, and the gas in the container concerned and the gas permutation process of permuting the open air gradually.
[Claim 2] Said resist film formation approach is the resist film formation approach according to claim 1 characterized by including the clearance process which removes the resist of the periphery section of the substrate concerned after picking out said substrate from said container.
[Claim 3] A resist dropping means by which a resist is dropped on the substrate which is stopping or rotating, said substrate is rotated and said dropped resist is diffused on a substrate front face with a centrifugal force -- making -- the substrate top concerned -- abbreviation -- with a substrate revolution means to make the resist layer of uniform thickness form A well-closed container means to leave the substrate with which said resist layer was formed in the state of sealing, Resist film formation equipment characterized by having the gas within said well-closed container means, a gas permutation means to permute the open air gradually, and the desiccation means that carries out stoving of the resist layer on said substrate after the gas was permuted by said gas permutation means.
[Claim 4] Said well-closed container means is resist film formation equipment according to claim 3 characterized by having opening which permutes an internal gas and the internal open air.
[Claim 5] Said well-closed container means is resist film formation equipment according to claim 3 or 4 characterized by having the substrate attaching part which holds the substrate concerned in the condition that the front face of said substrate becomes level.
[Claim 6] Said substrate attaching part is resist film formation equipment according to claim 5 characterized by having the curvature amendment function which amends the curvature of said substrate.
[Claim 7] Said substrate attaching part is resist film formation equipment according to claim 6 characterized by having a flat holder and the vacuum adsorption device in which carry out vacuum adsorption and said substrate is stuck on the holder concerned, sticking said substrate to the flat holder concerned, and amending the curvature of the substrate concerned.
[Claim 8] Said substrate attaching part is resist film formation equipment according to claim 6 characterized by having a flat holder and the electrostatic adsorption device in which carry out electrostatic adsorption and said substrate is stuck on the holder concerned, sticking said substrate to the flat holder concerned, and amending the curvature of the substrate concerned.
[Claim 9] Resist film which is resist film with which a resist is dropped and formed on a substrate, and is characterized by being formed in either of the resist film formation approach according to claim 1 or 2

or claim 3 to claims 8 with the resist film formation equipment of a publication.

[Translation done.]

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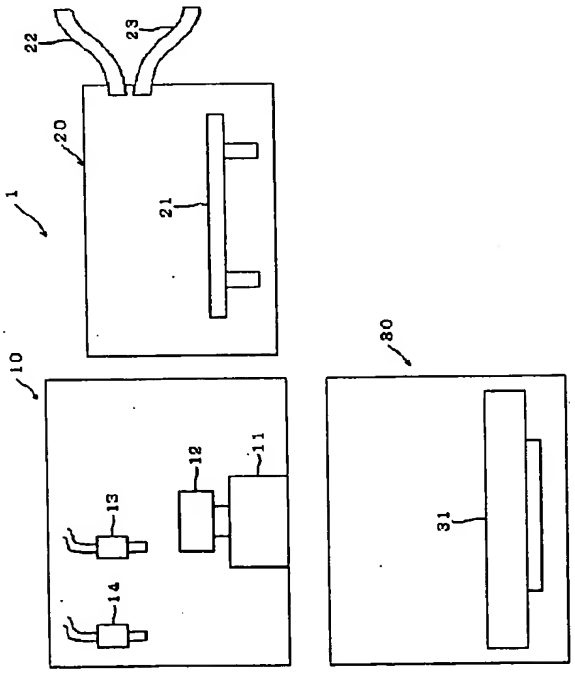
(54)【発明の名称】　レジスト膜形成方法、レジスト膜形成装置及びレジスト膜

(57)【要約】
【課題】本発明は均一な膜厚でレジストの塗布を行うレジスト膜形成方法、レジスト膜形成装置及びレジスト膜を提供する。
【解決手段】レジスト膜形成装置１は、停止又は回転する基板上にスピンコーター１０でレジストを滴下して、基板を回転させて遠心力でレジストを基板表面に拡散させて基板上に略均一な膜厚のレジスト層を形成し、基板４０上に塗布したレジスト５０を密閉容器２０内で一定時間水平な状態に放置して、密閉容器２０内の気体と外気を徐々に置換する。従って、レジストから蒸発する溶剤の蒸気が密閉容器２０内で飽和して、容器２０内でのレジストの乾燥を抑制し、レジストが流動して表面を平坦にできるとともに、平坦になった後、容器２０内の溶剤の蒸気圧を徐々に下げることでレジスト膜全体を均一に乾燥させて、レジストの表面荒れを防ぎ、表面荒れがなく平坦なレジスト膜を形成することができる。



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【特許請求の範囲】

【請求項１】停止または回転している基板上にレジストを滴下し、基板を回転させて遠心力でレジストを基板表面に拡散させて基板上に略均一な膜厚のレジスト層を形成するレジスト塗布工程と、基板上のレジスト層を加熱乾燥させる乾燥工程と、を行うレジスト膜形成方法において、前記レジスト塗布工程でレジストの塗布された基板を密閉された容器内に一定時間放置する放置工程と、当該容器内の気体と外気を徐々に置換する気体置換工程と、を含むことを特徴とするレジスト膜形成方法。

【請求項２】前記レジスト膜形成方法は、前記基板を前記容器から取り出した後、当該基板の外周部のレジストを除去する除去工程を含むことを特徴とする請求項１記載のレジスト膜形成方法。

【請求項３】停止または回転している基板上にレジストを滴下するレジスト滴下手段と、前記基板を回転させて遠心力で前記滴下されたレジストを基板表面に拡散させて当該基板上に略均一な膜厚のレジスト層を形成させる基板回転手段と、前記レジスト層の形成された基板を密閉状態で放置する密閉容器手段と、前記密閉容器手段内の気体と外気を徐々に置換する気体置換手段と、前記気体置換手段で気体の置換された後の前記基板上のレジスト層を加熱乾燥する乾燥手段と、を備えていることを特徴とするレジスト膜形成装置。

【請求項４】前記密閉容器手段は、内部の気体と外気を置換する開口部を備えていることを特徴とする請求項３記載のレジスト膜形成装置。

【請求項５】前記密閉容器手段は、前記基板の表面が水平になる状態で当該基板を保持する基板保持部を備えていることを特徴とする請求項３または請求項４記載のレジスト膜形成装置。

【請求項６】前記基板保持部は、前記基板の反りを補正する反り補正機能を備えていることを特徴とする請求項５記載のレジスト膜形成装置。

【請求項７】前記基板保持部は、平坦なホルダと、当該ホルダ上に前記基板を真空吸着して密着させる真空吸着機構と、を備え、当該平坦なホルダに前記基板を密着させて当該基板の反りを補正することを特徴とする請求項６記載のレジスト膜形成装置。

【請求項８】前記基板保持部は、平坦なホルダと、当該ホルダ上に前記基板を静電吸着して密着させる静電吸着機構と、を備え、当該平坦なホルダに前記基板を密着させて当該基板の反りを補正することを特徴とする請求項６記載のレジスト膜形成装置。

【請求項９】基板上にレジストが滴下されて形成されるレジスト膜であって、請求項１または請求項２記載のレジスト膜形成方法あるいは請求項３から請求項８のいずれかに記載のレジスト膜形成装置で形成されることを特徴とするレジスト膜。

【発明の詳細な説明】

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【０００１】

【発明の属する技術分野】本発明は、レジスト膜形成方法、レジスト膜形成装置及びレジスト膜に関し、詳細には、マイクロマシン、マイクロレンズの作成等に用いられる均一な膜厚でレジストの塗布を行うレジスト膜形成方法、レジスト膜形成装置及びレジスト膜に関する。

【０００２】

【従来の技術】フォトリソグラフィ技術は、主に、半導体分野において開発が進められてきたが、近時、マイクロマシニング等においても使用されるようになり、利用されるレジストの膜厚や下地基板の材質、形状も様々なものが使われるようになってきている。

【０００３】フォトリソグラフィにおいては、正確にパターンを転写するためには、レジスト膜がムラなく平坦に塗布されていることが必要であるが、レジスト膜の膜厚が数１０ｕｍになるような場合や基板に大きな段差がある場合には、レジスト膜を均一に塗布することが困難である。

【０００４】具体的には、レジスト膜を厚く塗る場合には、スピンコートした直後は膜厚が均一な場合でも、乾燥に時間がかかるため、乾燥むらにより膜厚が大きく変動したり、レジスト表面と内部の乾燥速度の差と乾燥による収縮で表面に亀甲状の模様が発生したりする場合がある。また、高い段差のある基板に対してスピンコートを行う場合には、段差部の中心側と周辺側で非対称な膜厚になったり、パターンの切れ目から放射状にムラが発生したりする。

【０００５】そこで、従来、回転若しくは停止されている基板の一面上に塗布液の溶剤を塗布する工程と、上記溶剤が塗布された基板を第１の回転数で回転させて、溶剤を基板の一面全体に渡って拡散させる工程と、上記基板のほぼ中心部上に、所定量の塗布液を、基板を第２の回転数で回転させて、基板の一面全体に渡って拡散させて塗布膜を形成する工程とを有する塗布膜形成方法が提案されており、また、この提案の中で、基板を回転させながらレジストを基板表面に広げる際に、基板周辺を溶剤の飽和雰囲気にしてレジストの乾燥を防ぎ、塗布ムラを避ける方法も提案されている（特開平７－３２０９９９号公報参照）。

【０００６】また、従来、半導体ウエハを水平に保持する手段と、前記半導体ウエハの表面の中心部にレジストを滴下する手段と、前記半導体ウエハを保持する手段を前記半導体ウエハと共に回転させる手段と、前記半導体ウエハを取り囲む手段とを備え、前記半導体ウエハを取り囲む手段は、前記半導体ウエハと共に回転するレジスト塗布装置が提案されている（特開平６－２６０４０４号公報参照）。

【０００７】すなわち、この従来のレジスト塗布装置は、レジストの飛散を押さえるためにウエハ周辺を囲んでいるカップと蓋を使って基板を密閉し、それらを基板

と一緒に回転させることでウエハ周辺の気流の制御とレジスト表面の乾燥を防止し、平らな表面が得られるようにしている。

【０００８】さらに、従来、液状のフォトレジストを基板に塗布してフォトレジスト膜を得る工程と、得られたフォトレジスト膜を減圧雰囲気のもとに所定時間乾燥させる工程を有するフォトレジストの塗布方法が提案されている（特開平８－１９４３１６号公報参照）。

【０００９】すなわち、この従来のフォトレジストの塗布方法は、スピンコーターで基板にレジストを塗り広げた後に、真空チャンバーに基板を入れて、減圧した状態で乾燥することで、塗布後、乾燥するまでの間に発生する乾燥ムラを防いでいる。

【００１０】

【発明が解決しようとする課題】上記公報記載の技術にあっては、レジストの溶剤雰囲気中でスピンコートを行い、表面の乾燥によるむらを防いだり、スピンコート後に減圧チャンバーに基板を入れて、レジストを減圧乾燥させている。

【００１１】ところが、溶剤雰囲気中で回転させる方法では、回転中の表面乾燥は避けられるが、レジストを高温乾燥させる際の膜厚変動を避けることはできず、また、減圧チャンバーによる乾燥方法では、高温乾燥前にレジストが流動しないようにすることはできるが、表面荒れやレジストの変質が起こる可能性がある。さらに、回転塗布を行う方法では、段差によってレジスト膜厚が非対称になってしまうという問題がある。

【００１２】そこで、本発明は、レジスト膜厚が非常に厚い場合や下地に大きな段差がある場合であっても、表面荒れが無く平坦なレジスト膜を形成することのできるレジスト膜形成方法、レジスト膜形成装置及びレジスト膜を提供することを目的としている。

【００１３】具体的には、請求項１記載の発明は、停止または回転している基板上にレジストを滴下して、基板を回転させて遠心力でレジストを基板表面に拡散させて基板上に略均一な膜厚のレジスト層を形成し、基板上のレジスト層を加熱乾燥させて行うレジスト膜を形成するに際して、レジストの塗布された基板を密閉された容器内に一定時間放置し、当該容器内の気体と外気を徐々に置換することにより、レジストを塗布した直後に基板を密閉容器に入れて、レジストから蒸発する溶剤の蒸気が密閉容器内で飽和することで、容器内でのレジストの乾燥を抑制し、レジストが流動して、表面を平坦にするとともに、平坦になった後、容器内の溶剤の蒸気圧を徐々に下げることで、レジスト膜全体を均一に乾燥させて、レジストの表面荒れを防ぎ、膜厚の厚いレジストや段差のある基板に対しても、表面荒れがなく平坦なレジスト膜を精度よく形成することのできるレジスト膜形成方法を提供することを目的としている。

【００１４】請求項２記載の発明は、基板を容器から取り出した後、当該基板の外周部のレジストを除去することにより、厚膜レジストを用いた場合でも外周部のレジストを除去し、表面荒れがなく平坦なレジスト膜を精度よく形成することのできるレジスト膜形成方法を提供することを目的としている。

【００１５】請求項３記載の発明は、停止または回転している基板上にレジストを滴下して、基板を回転させて遠心力でレジストを基板表面に拡散させて基板上に略均一な膜厚のレジスト層を形成し、基板上のレジスト層を加熱乾燥させて行うレジスト膜を形成するに際して、レジストの塗布された基板を密閉容器手段内に一定時間放置し、当該密閉容器手段内の気体と外気を徐々に置換することにより、レジストを塗布した直後に基板を密閉容器手段に入れて、レジストから蒸発する溶剤の蒸気が密閉容器手段内で飽和することで、密閉容器手段内でのレジストの乾燥を抑制し、レジストが流動して、表面を平坦にするとともに、平坦になった後、密閉容器手段内の溶剤の蒸気圧を徐々に下げることで、レジスト膜全体を均一に乾燥させて、レジストの表面荒れを防ぎ、膜厚の厚いレジストや段差のある基板に対しても、表面荒れがなく平坦なレジスト膜を精度よく形成することのできるレジスト膜形成装置を提供することを目的としている。

【００１６】請求項４記載の発明は、密閉容器手段に、内部の気体と外気を置換する開口部を設けることにより、基板密閉手段内部の雰囲気のコントロールを容易に行い、簡単かつレジスト膜全体をより均一に乾燥させて、膜厚の厚いレジストや段差のある基板に対しても、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することのできるレジスト膜形成装置を提供することを目的としている。

【００１７】請求項５記載の発明は、密閉容器手段に、基板の表面が水平になる状態で当該基板を保持する基板保持部を設けることにより、基板の傾斜でレジスト膜厚が偏ってしまうことを防止し、膜厚の厚いレジストや段差のある基板に対しても、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することのできるレジスト膜形成装置を提供することを目的としている。

【００１８】請求項６記載の発明は、基板保持部に、基板の反りを補正する反り補正機能を持たせることにより、反りがあるような基板に対しても平坦なレジスト膜を形成し、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することのできるレジスト膜形成装置を提供することを目的としている。

【００１９】請求項７記載の発明は、基板保持部を、平坦なホルダと、当該ホルダ上に前記基板を真空吸着して密着させる真空吸着機構と、を備え、当該平坦なホルダに前記基板を密着させて当該基板の反りを補正するものとすることにより、反りがあるような基板に対しても平坦なレジスト膜を適切かつ容易に形成し、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成す

ることのできるレジスト膜形成装置を提供することを目的としている。

【００２０】請求項８記載の発明は、基板保持部を、平坦なホルダと、当該ホルダ上に前記基板を静電吸着して密着させる静電吸着機構と、を備え、当該平坦なホルダに前記基板を密着させて当該基板の反りを補正するものとすることにより、反りがあるような基板に対しても平坦なレジスト膜を適切かつ容易に形成し、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することのできるレジスト膜形成装置を提供することを目的としている。

【００２１】請求項９記載の発明は、基板上にレジストが滴下されて形成されるレジスト膜を、請求項１または請求項２記載のレジスト膜形成方法あるいは請求項３から請求項８のいずれかに記載のレジスト膜形成装置で形成することにより、反りがあるような基板に対しても平坦なレジスト膜を適切かつ容易に形成し、表面荒れがなく平坦なレジスト膜を精度よく形成して、３次元的なレジストパターンを作成したり、段差付き基板上にパターニングを行う場合の歩留まりが向上させることのできるレジスト膜を提供することを目的としている。

【００２２】

【課題を解決するための手段】請求項１記載の発明のレジスト膜形成方法は、停止または回転している基板上にレジストを滴下し、基板を回転させて遠心力でレジストを基板表面に拡散させて基板上に略均一な膜厚のレジスト層を形成するレジスト塗布工程と、基板上のレジスト層を加熱乾燥させる乾燥工程と、を行うレジスト膜形成方法において、前記レジスト塗布工程でレジストの塗布された基板を密閉された容器内に一定時間放置する放置工程と、当該容器内の気体と外気を徐々に置換する気体置換工程と、を含むことにより、上記目的を達成している。

【００２３】上記構成によれば、停止または回転している基板上にレジストを滴下して、基板を回転させて遠心力でレジストを基板表面に拡散させて基板上に略均一な膜厚のレジスト層を形成し、基板上のレジスト層を加熱乾燥させて行うレジスト膜を形成するに際して、レジストの塗布された基板を密閉された容器内に一定時間放置し、当該容器内の気体と外気を徐々に置換するので、レジストを塗布した直後に基板を密閉容器に入れて、レジストから蒸発する溶剤の蒸気が密閉容器内で飽和することで、容器内でのレジストの乾燥を抑制することができ、レジストが流動して、表面を平坦にすることができるとともに、平坦になった後、容器内の溶剤の蒸気圧を徐々に下げることで、レジスト膜全体を均一に乾燥させて、レジストの表面荒れを防ぐことができ、膜厚の厚いレジストや段差のある基板に対しても、表面荒れがなく平坦なレジスト膜を精度よく形成することができる。

【００２４】この場合、例えば、請求項２に記載するように、前記レジスト膜形成方法は、前記基板を前記容器から取り出した後、当該基板の外周部のレジストを除去する除去工程を含んでいてもよい。

【００２５】上記構成によれば、基板を容器から取り出した後、当該基板の外周部のレジストを除去するので、厚膜レジストを用いた場合でも外周部のレジストを除去することができ、表面荒れがなく平坦なレジスト膜を精度よく形成することができる。

【００２６】請求項３記載の発明のレジスト膜形成装置は、停止または回転している基板上にレジストを滴下するレジスト滴下手段と、前記基板を回転させて遠心力で前記滴下されたレジストを基板表面に拡散させて当該基板上に略均一な膜厚のレジスト層を形成させる基板回転手段と、前記レジスト層の形成された基板を密閉状態で放置する密閉容器手段と、前記密閉容器手段内の気体と外気を徐々に置換する気体置換手段と、前記気体置換手段で気体の置換された後の前記基板上のレジスト層を加熱乾燥する乾燥手段と、を備えることにより、上記目的を達成している。

【００２７】上記構成によれば、停止または回転している基板上にレジストを滴下して、基板を回転させて遠心力でレジストを基板表面に拡散させて基板上に略均一な膜厚のレジスト層を形成し、基板上のレジスト層を加熱乾燥させて行うレジスト膜を形成するに際して、レジストの塗布された基板を密閉容器手段内に一定時間放置し、当該密閉容器手段内の気体と外気を徐々に置換するので、レジストを塗布した直後に基板を密閉容器手段に入れて、レジストから蒸発する溶剤の蒸気が密閉容器手段内で飽和することで、密閉容器手段内でのレジストの乾燥を抑制することができ、レジストが流動して、表面を平坦にすることができるとともに、平坦になった後、密閉容器手段内の溶剤の蒸気圧を徐々に下げることで、レジスト膜全体を均一に乾燥させて、レジストの表面荒れを防ぐことができ、膜厚の厚いレジストや段差のある基板に対しても、表面荒れがなく平坦なレジスト膜を精度よく形成することができる。

【００２８】この場合、例えば、請求項４に記載するように、前記密閉容器手段は、内部の気体と外気を置換する開口部を備えていてもよい。

【００２９】上記構成によれば、密閉容器手段に、内部の気体と外気を置換する開口部を設けているので、基板密閉手段内部の雰囲気のコントロールを容易に行うことができ、簡単かつレジスト膜全体をより均一に乾燥させて、膜厚の厚いレジストや段差のある基板に対しても、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することができる。

【００３０】また、例えば、請求項５に記載するように、前記密閉容器手段は、前記基板の表面が水平になる状態で当該基板を保持する基板保持部を備えていてもよい。

【００３１】上記構成によれば、密閉容器手段に、基板の表面が水平になる状態で当該基板を保持する基板保持部を設けているので、基板の傾斜でレジスト膜厚が偏ってしまうことを防止することができ、膜厚の厚いレジストや段差のある基板に対しても、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することができる。

【００３２】さらに、例えば、請求項６に記載するように、前記基板保持部は、前記基板の反りを補正する反り補正機能を備えていてもよい。

【００３３】上記構成によれば、基板保持部に、基板の反りを補正する反り補正機能を持たせているので、反りがあるような基板に対しても平坦なレジスト膜を形成することができ、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することができる。

【００３４】また、例えば、請求項７に記載するように、前記基板保持部は、平坦なホルダと、当該ホルダ上に前記基板を真空吸着して密着させる真空吸着機構と、を備え、当該平坦なホルダに前記基板を密着させて当該基板の反りを補正するものであってもよい。

【００３５】上記構成によれば、基板保持部を、平坦なホルダと、当該ホルダ上に前記基板を真空吸着して密着させる真空吸着機構と、を備え、当該平坦なホルダに前記基板を密着させて当該基板の反りを補正するものとしているので、反りがあるような基板に対しても平坦なレジスト膜を適切かつ容易に形成することができ、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することができる。

【００３６】さらに、例えば、請求項８に記載するように、前記基板保持部は、平坦なホルダと、当該ホルダ上に前記基板を静電吸着して密着させる静電吸着機構と、を備え、当該平坦なホルダに前記基板を密着させて当該基板の反りを補正するものであってもよい。

【００３７】上記構成によれば、基板保持部を、平坦なホルダと、当該ホルダ上に前記基板を静電吸着して密着させる静電吸着機構と、を備え、当該平坦なホルダに前記基板を密着させて当該基板の反りを補正するものとしているので、反りがあるような基板に対しても平坦なレジスト膜を適切かつ容易に形成することができ、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することができる。

【００３８】請求項９記載の発明のレジスト膜は、基板上にレジストが滴下されて形成されるレジスト膜であって、請求項１または請求項２記載のレジスト膜形成方法あるいは請求項３から請求項８のいずれかに記載のレジスト膜形成装置で形成されることにより、上記目的を達成している。

【００３９】上記構成によれば、基板上にレジストが滴下されて形成されるレジスト膜を、請求項１または請求項２記載のレジスト膜形成方法あるいは請求項３から請求項８のいずれかに記載のレジスト膜形成装置で形成しているので、反りがあるような基板に対しても平坦なレジスト膜を適切かつ容易に形成することができ、表面荒れがなく平坦なレジスト膜を精度よく形成して、３次元的なレジストパターンを作成したり、段差付き基板上にパターニングを行う場合の歩留まりを向上させることができる。

【００４０】

【発明の実施の形態】以下、本発明の好適な実施の形態を添付図面に基づいて詳細に説明する。なお、以下に述べる実施の形態は、本発明の好適な実施の形態であるから、技術的に好ましい種々の限定が付されているが、本発明の範囲は、以下の説明において特に本発明を限定する旨の記載がない限り、これらの態様に限られるものではない。

【００４１】図１～図８は、本発明のレジスト膜形成方法、レジスト膜形成装置及びレジスト膜の一実施の形態を示す図であり、図１は、本発明のレジスト膜形成方法、レジスト膜形成装置及びレジスト膜の一実施の形態を適用したレジスト膜形成装置の概略構成図である。

【００４２】図１において、レジスト膜形成装置１は、スピンコーター１０、密閉容器２０及びホットプレート容器３０等を備えている。

【００４３】スピンコーター（レジスト滴下手段、基板回転手段）１０は、モータ１１、モータ１１の軸に連結された基板ホルダ１２及び２個のディスペンサー１３、１４等を備えているとともに、図示しないが、スピンコーター１０内の雰囲気を制御するエアコントローラ等を備えており、モータ１１上に載置される基板４０（図２参照）にレジストを塗布する。

【００４４】密閉容器（密閉容器手段）２０は、レジストが塗布された基板４０を密閉するための容器であり、基板保持用ステージ２１、密閉容器２０内へ外気を導入するための外気取り込み口（気体置換手段、開口部）２２及び密閉容器２０内の気体を排出するための排気口（気体置換手段、開口部）２３等を備えている。なお、密閉容器２０は、基板４０を搬送するための搬送装置やレジスト塗布前の基板４０にレジスト密着層を形成するための装置等を備えていてもよい。

【００４５】ホットプレート容器（乾燥手段）３０は、ホットプレート３１を収容しており、レジスト膜の形成された基板４０をベークして、レジスト膜を露光に適した状態に乾燥する。

【００４６】次に、レジスト膜形成装置１を用いたレジスト膜形成プロセスについて、図２から図７に基づいて説明する。

【００４７】まず、図２に示すように、ＨＭＤＳ（ヘキサメチルジシラザン）処理等でレジストの密着性をあげるための表面処理を行った基板４０を、スピンコーター１０の基板ホルダ１２に保持させ、モータ１１を静止ま

たは低速（１０００ｒｐｍ以下程度）で回転させながら基板４０上にレジスト５０を滴下する。そして、基板４０の全面に十分行き渡る程度のレジスト５０を滴下した後、図３に示すように、基板４０の回転の遠心力でレジスト５０が基板４０の表面全体に行き渡り、必要な膜厚になるようにモータ１１を回転させるレジスト塗布工程を行う。

【００４８】このとき、不要なレジスト５０は、基板４０の回転の遠心力で基板４０の外に振り落とされるが、それでも基板４０の外周部には厚くレジスト５０が残ってしまうため、最後に、数秒高速回転させて周囲のレジスト５０を除去してもよい。この段階では基板４０の表面は、完全に平坦な必要はなく、目標の膜厚を形成するのに必要な量のレジスト５０が基板４０上に残っていればよい。また、この時点では、レジスト５０の表面が乾燥しないようにしておく必要があるため、不要なレジスト５０が除去されすると、直ちに、モータ１１の回転を停止するなどして処理時間を短縮したり、基板４０の周辺の雰囲気をレジスト溶剤の飽和雰囲気にしておくことが望ましい。

【００４９】上述のようにして基板４０にレジスト５０を塗布すると、図４に示すように、速やかに基板４０を密閉容器２０内に移動させて、一定時間放置する放置工程を行う。このとき、密閉容器２０内は、基板４０の表面から蒸発するレジスト５０の溶媒により、溶媒の飽和雰囲気になるため、レジスト５０は、乾燥することなく、基板４０上で流動する。また、基板４０は、密閉容器２０内で基板保持用ステージ２１に水平に保持され、基板４０の表面に大きな反りやうねりのない状態となっている。なお、基板４０にうねりやそりがある場合は、密閉容器２０内の基板保持用ステージ（ホルダ）２１として、基板４を真空吸着や静電吸着して強制的に平坦にするものを使用して、反り補正機能を持たせる。このような状態にしておくことで、レジスト５０の粘性や膜厚にも依存するが、数分程度で基板４０の表面が平坦になる。

【００５０】次に、図５に示すように、密閉容器２０の外気取り込み口２２を開いて、内部のレジスト溶媒雰囲気の濃度を下げ、レジスト５０を乾燥させてレジスト５０が流動しないようにする気体置換工程を行う。この場合、密閉容器２０内のレジスト溶媒蒸気を外気取り込み口２２から自然に拡散させることで、密閉容器２０内のレジスト溶剤蒸気の濃度を徐々に下げて、ゆっくりレジスト５０を乾燥させる。この際、密閉容器２０内に強制的に外気を取り入れ、密閉容器２０内部の雰囲気を排気するようにしてもよいが、あまりに急激に外気の取り入れを行うと、レジスト５０の乾燥ムラが発生して、レジスト５０の表面に凹凸が生じる場合があるため、表面荒れがおきない程度に外気の強制的な取り入れを行う。

【００５１】密閉容器２０内に外気を取り入れる場合、密閉容器２０内部に発生する気流も表面荒れの発生原因になるため、外気取り込み口２２を密閉容器２０内部に気流が発生しにくい形状にする。

【００５２】なお、上記実施の形態では、外気取り入れ口２２を密閉容器２０に取り付けた場合について説明したが、密閉容器２０の蓋の開け具合で調整するようにしてもよい。

【００５３】次に、密閉容器２０から基板４０を取出し、図６に示すように、スピンコーター１０に戻して、ディスペンサー１４からレジスト溶媒または周辺部洗浄専用の溶剤１５を用いて、基板４０の周辺部のレジスト５０を除去する除去工程を行う。すなわち、レジスト５０は、図５に示したように、基板４０の周辺部、特に、エッジ近辺で、レジスト５０のエッジが盛り上がってしまう場合があり、また、リソグラフィ後にエッチング等の処理を行う場合は、このエッジ部分をクランプで押さえて基板４０を固定するため、レジスト５０を除去しておくことが望ましい。なお、図３のモータ１１を回転させてレジスト５０を均一にする段階でレジスト５０の周辺部の除去を行わないのは、この段階では周辺部のレジスト５０を除去しても、レジスト５０が流動してエッジまで流れてしまうためである。また、１ｕｍ程度のレジスト５０を平坦な基板４０に塗布する場合は、図３の段階で、同時にレジスト５０の周辺部の除去も行っているが、この場合は、モータ１１を回転させながらレジスト５０の乾燥も同時に行っているためであり、厚いレジスト５０を形成する場合には、回転させながら乾燥させることが困難であるため、図６の段階で、レジスト５０の周辺部の除去を行う。

【００５４】そして、最後に、図７に示すように、周辺部のレジスト５０の除去を行った基板４０をホットプレート容器３０内のホットプレート３１上に設置し、ホットプレート３１でベークを行って、レジスト５０を露光に適した状態まで乾燥させる乾燥工程を行う。

【００５５】このようにして形成されたレジスト膜５０は、厚膜レジスト５０であっても表面を平坦にすることができ、ウエハ内でのレジスト膜厚の変動に敏感な製造プロセス、例えば、３次元的なレジストパターンを作成するプロセス等においても製造プロセスの歩留まりを向上させることができる。また、下地の凹凸が激しい基板４０に対して、ステッパーを用いて露光するような場合においても、下地段差部の基板４０の中心側と外周側での膜厚変動を減らすことができ、露光ショット間の寸法バラツキを低減することができる。

【００５６】このように、本実施の形態のレジスト膜形成方法及びレジスト膜形成装置１は、スピンコーター１０で基板４０上に塗布したレジスト５０を、密閉容器２０内で、一定時間水平な状態にしている。

【００５７】したがって、レジスト５０の流動性によりむらが発生しやすい厚いレジスト５０や下地に段差のあ

る基板４０に対しても平坦なレジスト膜５０を形成することができる。

【００５８】また、本実施の形態のレジスト膜形成方法及びレジスト膜形成装置１は、密閉容器２０内をレジスト溶媒雰囲気にするため、基板４０に塗布されたレジスト５０から蒸発する溶媒を利用している。

【００５９】したがって、溶媒雰囲気にするための装置を追加する必要がなく、また、平坦になったレジスト膜５０を静止したまま飽和状態よりも若干薄いレジスト溶媒雰囲気中で乾燥させることにより、レジスト表面荒れを防ぐことができる。

【００６０】なお、上記内部に気流の発生しにくい密閉容器２０としては、例えば、図８に示すような密閉容器（密閉容器手段）６０を用いることができる。この密閉容器６０は、内部が上側に形成された前室６１と下側に形成された本室６２とに隔壁６３で区分されており、隔壁６３には、前室６１と本室６２とを連通する開口６４が形成されている。本室６２内に基板保持用ステージ２１が配設されており、この基板保持用ステージ２１上に本室６２の側面に形成されたウエハ導入口からレジスト５０の塗布された基板４０が導入されて載置される。このウエハ導入口は、蓋６５で塞がれており、蓋６５は、基板４０の挿入時と取出時に開かれる。密閉容器６０では、前室６１の上部中央部に吸気口（気体置換手段、開口部）６６が開口されており、本室６２の下部には、本室６２内の気体を外部に排出する排気口（気体置換手段、開口部）６７が形成されている。

【００６１】この密閉容器６０では、吸気口６６から入った空気が、まず、前室６１に導入され、前室６１に導入された空気が、隔壁６３に多数設けられた開口６４から均等に基板４０の置かれている本室６２内の基板４０上へ供給されて、レジスト溶剤の蒸気を含んだ気体が、排気口６７から排出される。レジスト溶剤の蒸気を含む排気を外に出したくない場合は、このような密閉容器６０の形状にして排気を行った方が排気の管理を容易に行うことができる。

【００６２】以上、本発明者によってなされた発明を好適な実施の形態に基づき具体的に説明したが、本発明は上記のものに限定されるものではなく、その要旨を逸脱しない範囲で種々変更可能であることはいうまでもない。

【００６３】

【発明の効果】請求項１記載の発明のレジスト膜形成方法によれば、停止または回転している基板上にレジストを滴下して、基板を回転させて遠心力でレジストを基板表面に拡散させて基板上に略均一な膜厚のレジスト層を形成し、基板上のレジスト層を加熱乾燥させて行うレジスト膜を形成するに際して、レジストの塗布された基板を密閉された容器内に一定時間放置し、当該容器内の気体と外気を徐々に置換するので、レジストを塗布した直後に基板を密閉容器に入れて、レジストから蒸発する溶剤の蒸気が密閉容器内で飽和することで、容器内でのレジストの乾燥を抑制することができ、レジストが流動して、表面を平坦にすることができるとともに、平坦になった後、容器内の溶剤の蒸気圧を徐々に下げることで、レジスト膜全体を均一に乾燥させて、レジストの表面荒れを防ぐことができ、膜厚の厚いレジストや段差のある基板に対しても、表面荒れがなく平坦なレジスト膜を精度よく形成することができる。

【００６４】請求項２記載の発明のレジスト膜形成方法によれば、基板を容器から取り出した後、当該基板の外周部のレジストを除去するので、厚膜レジストを用いた場合でも外周部のレジストを除去することができ、表面荒れがなく平坦なレジスト膜を精度よく形成することができる。

【００６５】請求項３記載の発明のレジスト膜形成装置によれば、停止または回転している基板上にレジストを滴下して、基板を回転させて遠心力でレジストを基板表面に拡散させて基板上に略均一な膜厚のレジスト層を形成し、基板上のレジスト層を加熱乾燥させて行うレジスト膜を形成するに際して、レジストの塗布された基板を密閉容器手段内に一定時間放置し、当該密閉容器手段内の気体と外気を徐々に置換するので、レジストを塗布した直後に基板を密閉容器手段に入れて、レジストから蒸発する溶剤の蒸気が密閉容器手段内で飽和することで、密閉容器手段内でのレジストの乾燥を抑制することができ、レジストが流動して、表面を平坦にすることができるとともに、平坦になった後、密閉容器手段内の溶剤の蒸気圧を徐々に下げることで、レジスト膜全体を均一に乾燥させて、レジストの表面荒れを防ぐことができ、膜厚の厚いレジストや段差のある基板に対しても、表面荒れがなく平坦なレジスト膜を精度よく形成することができる。

【００６６】請求項４記載の発明のレジスト膜形成装置によれば、密閉容器手段に、内部の気体と外気を置換する開口部を設けているので、基板密閉手段内部の雰囲気のコントロールを容易に行うことができ、簡単かつレジスト膜全体をより均一に乾燥させて、膜厚の厚いレジストや段差のある基板に対しても、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することができる。

【００６７】請求項５記載の発明のレジスト膜形成装置によれば、密閉容器手段に、基板の表面が水平になる状態で当該基板を保持する基板保持部を設けているので、基板の傾斜でレジスト膜厚が偏ってしまうことを防止することができ、膜厚の厚いレジストや段差のある基板に対しても、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することができる。

【００６８】請求項６記載の発明のレジスト膜形成装置によれば、基板保持部に、基板の反りを補正する反り補

正機能を持たせているので、反りがあるような基板に対しても平坦なレジスト膜を形成することができ、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することができる。

【００６９】請求項７記載の発明のレジスト膜形成装置によれば、基板保持部を、平坦なホルダと、当該ホルダ上に前記基板を真空吸着して密着させる真空吸着機構と、を備え、当該平坦なホルダに前記基板を密着させて当該基板の反りを補正するものとしているので、反りがあるような基板に対しても平坦なレジスト膜を適切かつ容易に形成することができ、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することができる。

【００７０】請求項８記載の発明のレジスト膜形成装置によれば、基板保持部を、平坦なホルダと、当該ホルダ上に前記基板を静電吸着して密着させる静電吸着機構と、を備え、当該平坦なホルダに前記基板を密着させて当該基板の反りを補正するものとしているので、反りがあるような基板に対しても平坦なレジスト膜を適切かつ容易に形成することができ、より一層表面荒れがなく平坦なレジスト膜をより一層精度よく形成することができる。

【００７１】請求項９記載の発明のレジスト膜によれば、基板上にレジストが滴下されて形成されるレジスト膜を、請求項１または請求項２記載のレジスト膜形成方法あるいは請求項３から請求項８のいずれかに記載のレジスト膜形成装置で形成しているので、反りがあるような基板に対しても平坦なレジスト膜を適切かつ容易に形成することができ、表面荒れがなく平坦なレジスト膜を精度よく形成して、３次元的なレジストパターンを作成したり、段差付き基板上にパターニングを行う場合の歩留まりを向上させることができる。

【図面の簡単な説明】

【図１】本発明のレジスト膜形成方法、レジスト膜形成装置及びレジスト膜の一実施の形態を適用したレジスト膜形成装置の概略構成図。

【図２】図１のスピンコーターで基板上にレジストを滴下して塗布している状態を示す部分拡大正面図。

＊【図３】図２のスピンコーターのモータを回転して基板上のレジストを基板全体に行き渡らせている状態の部分拡大正面図。

【図４】図３のレジストの塗布された基板を図１の密閉容器内に移動させた状態の拡大正面図。

【図５】図４の密閉容器内に外気を導入して乾燥させている状態の拡大正面図。

【図６】図５の乾燥の完了したレジストを図１のスピンコーターに導入してレジストの周辺部を除去している状態の拡大正面図。

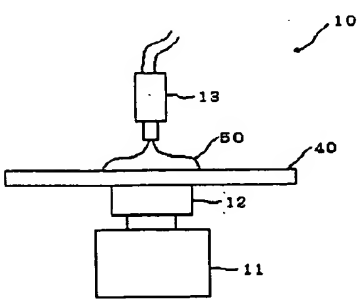
【図７】図６で周辺部の除去されたレジストと基板を図１のホットプレート容器内に収納して乾燥している状態の拡大正面図。

【図８】内部に気流の発生しにくい密閉容器の一例の正面図。

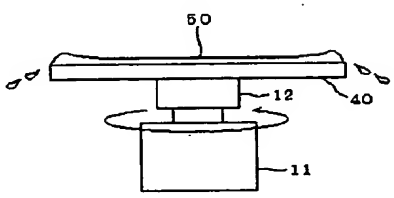
【符号の説明】

１　レジスト膜形成装置
１０　スピンコーター
１１　モータ
１２　基板ホルダ
１３、１４　ディスペンサー
２０　密閉容器
２１　基板保持用ステージ
２２　外気取り込み口
２３　排気口
３０　ホットプレート容器
３１　ホットプレート
４０　基板
５０　レジスト
６０　密閉容器
６１　前室
６２　本室
６３　隔壁
６４　開口
６５　蓋
６６　吸気口
６７　排気口

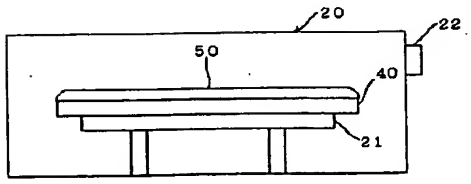
【図２】



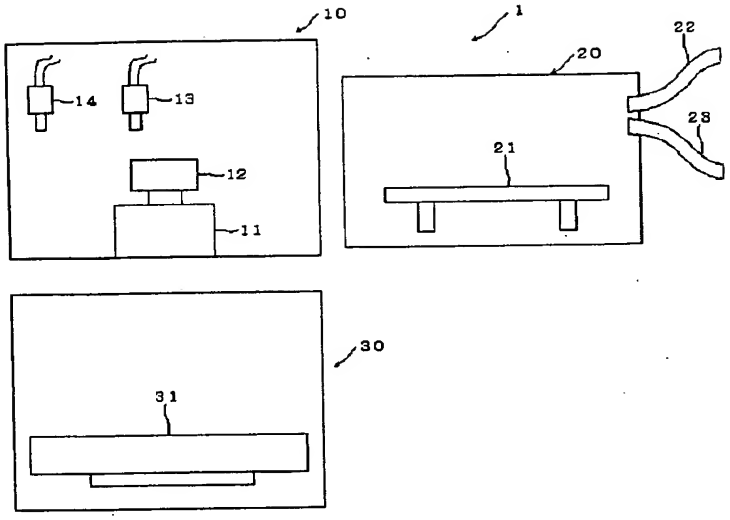
【図３】



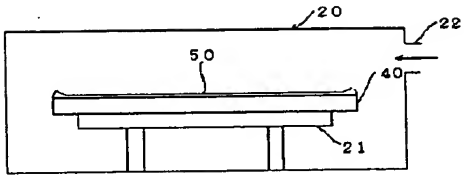
【図４】



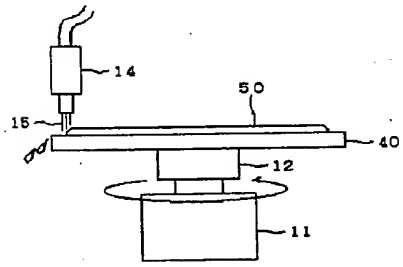
【図１】



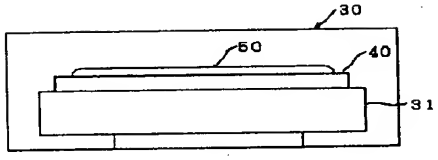
【図５】



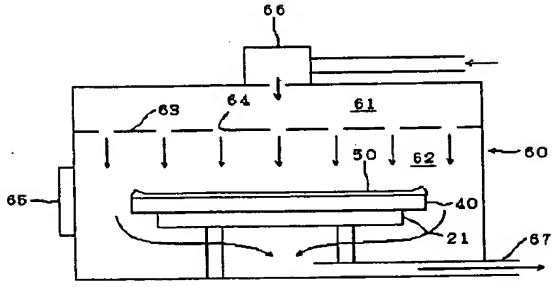
【図６】



【図７】



【図８】



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